Capabilities and Limitations of an Electron Beam Profile Monitor for Project X

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ABSTRACT

Fermilab has proposed several future projects to assume a new relevance at the head of the high-intensity frontier. However, the current instrumentation used at Fermilab to profile proton beams may not be suitable at higher intensities. In order to be successful at the high-intensity frontier, Fermilab must develop instrumentation devices that can withstand the higher intensities as well as provide accurate measurements of the proton beam properties. To determine if an electron beam profile monitor is feasible for the specific needs of the high-intensity proton beams proposed at Fermilab, we created computer simulations using MATLAB to model various techniques of measurement and analysis as well as to establish boundaries on the effectiveness of those techniques, using various electron and proton beam parameters. We also conducted experimental trials using a commercially procured electron beam source. We recorded the experimental value of the electron beam deflection using wires to simulate the proton beam current. The experimental results are in qualitative agreement with the theory, but our plan to use wires to simulate the proton beam presented a number of unexpected difficulties, which prevented a more detailed study. We concluded that at least two different techniques could meet Fermilab's needs, measuring the proton beam transverse sigma to within 5% of the true value and the longitudinal sigma to within 3% of the true value, for intensities up to 4e11 protons per bunch. Higher proton beam intensities can be dealt with by changing the electron beam parameters. This suggests that the electron beam profile monitor could be successfully implemented for Project X.